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TWO NEW SPECIES OF *GASTROPTERON*
(*GASTROPODA*: *OPISTHOBRANCHIA*)
FROM SOUTHERN AFRICA

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With Text-figures 1-10, Table 1 and Plate I

The Gastropteridae are a small family of cephalaspidean opisthobranch gastropods, consisting of 19 described species in three genera. The external morphology varies considerably between species and serves as the major basis for the separation of specific taxa. Little is known about the internal anatomy of most taxa, with the exception of the radular morphology. Differences in shape and number of radular plates provide the major basis for the separation of genera.

All described species have been recorded from the northern hemisphere. The only record from the southern hemisphere is that of Barnard (1963). He recorded an undescribed species from deep water off the Cape Peninsula of South Africa. The only other record of the family from the African continent is that of *Gastropteron rubrum manx* from off the coast of Nigeria, in the Gulf of Guinea (Marcus & Marcus, 1966). In the course of studying the opisthobranch fauna of southern Africa, living representatives of two undescribed species of *Gastropteron* were collected from the Atlantic coast of the Cape Peninsula, in the vicinity of Cape Town, South Africa. It is the intent of this paper to describe these species and to discuss their systematic position within the family.

Comparative material of described taxa was examined to confirm some of the previous morphological studies and to provide more detailed descriptions of some taxa. It was possible to examine a syntype specimen of *Gastropteron cinereum* Dall, 1925. Its morphology is more completely described and its taxonomic status is revised.

Abbreviations

a - ampulla	e - esophagus
bc - bursa copulatrix	fg - female gland mass
bg - buccal ganglion	ga - genital aperture
c - cerebral ganglion	os - osphradial ganglion
cr - crop	ot - ovotestis

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p - penis	s - spermatic bulb
pe - pedal ganglion	sa - salivary gland
pl - pleural ganglion	sb - subintestinal ganglion
pr - prostate	sbv- subintestinal-visceral ganglion
ra - radula sac	sg - sperm groove
rm- retractor muscle	sp - suprainestinal ganglion
rs - receptaculum seminis	v - visceral ganglion

Gastropteron flavobrunneum n. sp.

(Figs. 1-4, Pl. I Figs. 1, 2)

Holotype: South African Museum, Cape Town. SAM A 35241. Collected in 15 meters of water on a rocky pinnacle off Bakoven, on the Atlantic coast of the Cape Peninsula (33°50'S, 18°20' E) on September 16, 1982. **Paratypes:** South African Museum, Cape Town. SAM A 35240. Collected with the holotype; SAM A 35857. Collected in 20 meters of water on a rocky pinnacle off Llandudno, on the Atlantic coast of the Cape Peninsula (34°01'S, 18°20'E) on October 16, 1982.

Natural History. All three specimens were collected on the top of rocky pinnacles in 15-20 meters of water. They were in areas which were covered with dense aggregations of the mussel *Aulacomya ater* (Molina). No direct feeding observations were made. When disturbed the animals were able to swim for periods of two to three minutes by flapping their parapodia.

External morphology. The living specimens (Pl. 1 Figs. 1, 2) were four to seven mm in length. The ground color of the living animals is uniformly light yellow with minute, opaque white spots. There are isolated brown spots distributed over the surface of the head shield, visceral hump and parapodia. The head shield is triangular, broadest anteriorly. Its posterior end is involuted to form a siphon (Fig. 1A). The parapodia are relatively thin and fleshy. The foot extends posteriorly, well beyond the limit of the parapodia. The foot is broad and is posteriorly rounded. At the center of its anterior margin it is deeply incised. There is a large pedal gland with an elongate groove which runs the posterior third of the length of the foot (Fig. 2A).

The gill is situated on the right side of the body, near the anterior end of the visceral hump. It is simply plicate, consisting of 7-11 leaflets. The anus is immediately posterior to the gill. The genital aperture is anterior to the gill and empties into the sperm groove. The groove traverses the right side of the head to the male aperture.

Shell. The shell (Fig. 1C) is thinly and uniformly calcified. It is ovoid in shape. The protoconch is not clearly differentiated from the remainder of the shell.

Digestive system. The buccal mass (Fig. 1B) is elongate and muscular. Near its anterior limit is a ventral, glandular region. The radular sac is broad, forming the posteriormost portion of the buccal mass. On the dorsal side of the posterior limit of the buccal mass emerges the thin esophagus. On either side of the esophagus are the paired, tubular salivary glands. The esophagus expands into a

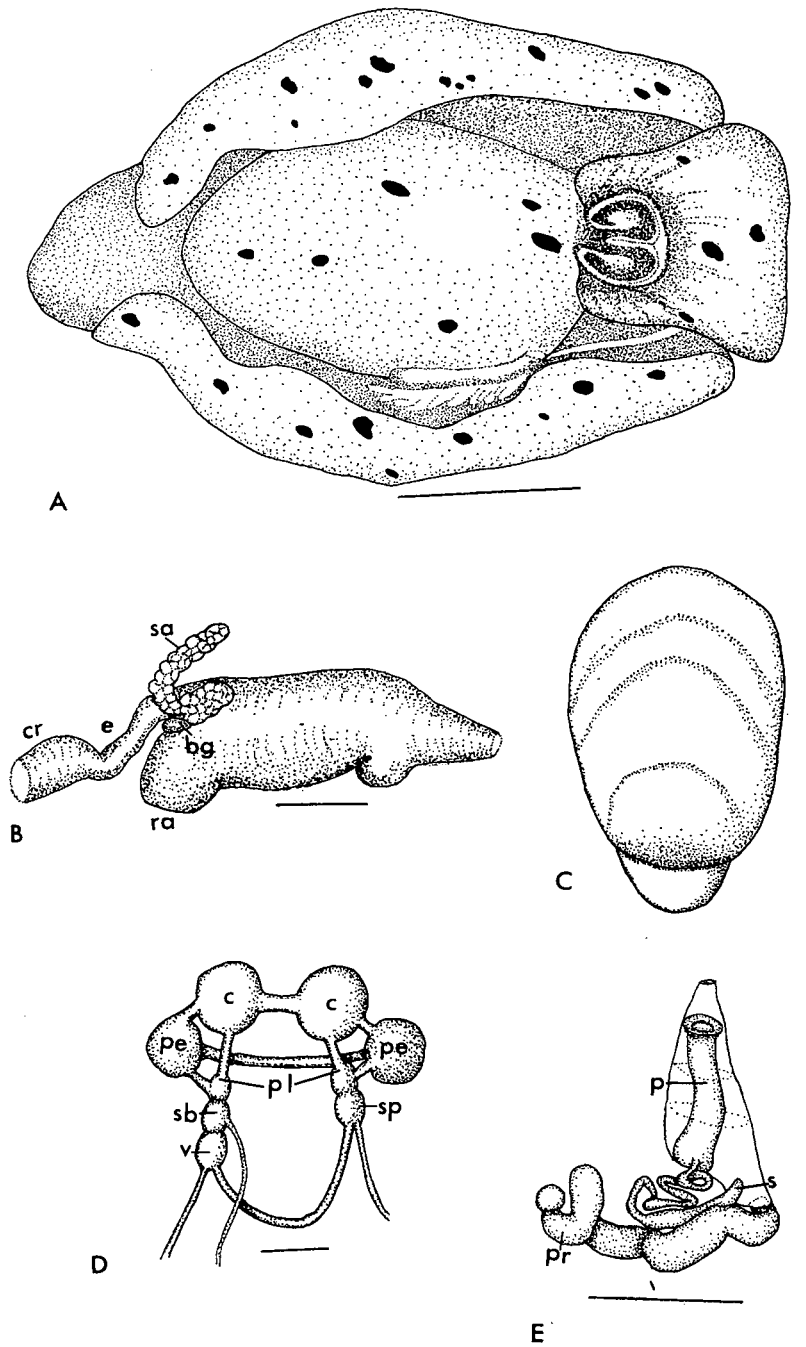


Fig. 1. *Gastropteron flavobrunneum* n. sp., A. dorsal view, scale=1.5 mm. B. buccal mass, scale=1.0 mm. C. shell, scale=0.5 mm. D. central nervous system, scale=0.25 mm. E. penis, scale=0.5 mm.

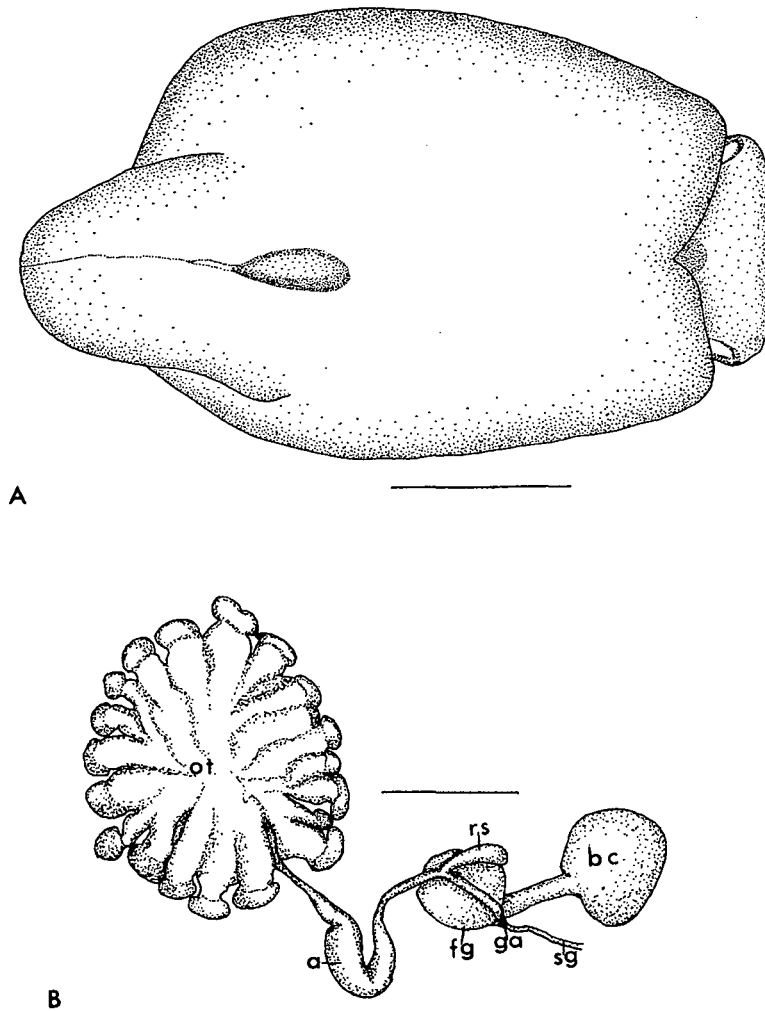


Fig. 2. *Gastropteron flavobrunneum* n. sp., A. ventral view, scale=1.5 mm. B. reproductive system, scale=0.5 mm.

thin-walled crop. The crop enters the large digestive gland. The course of the intestine, through the digestive gland, was not traced. It emerges from the right side of the digestive gland, terminating at the anus.

The anterior portion of the buccal mass is lined with a thin, transparent labial cuticle. It does not appear to have thickened jaws and no platelets were observed when the cuticle was examined microscopically. The radula is well developed (Figs. 3-4). Its formula is $19 \times 5-6.1.0.1.5-6$ in both paratypes. The innermost laterals are large ($90 \mu\text{m}$ in length) and broad, with a thickened outer margin. The inner margin is entirely devoid of denticles. The outer laterals are thinner and smaller, decreasing in size towards the outer margin of the radular ribbon.

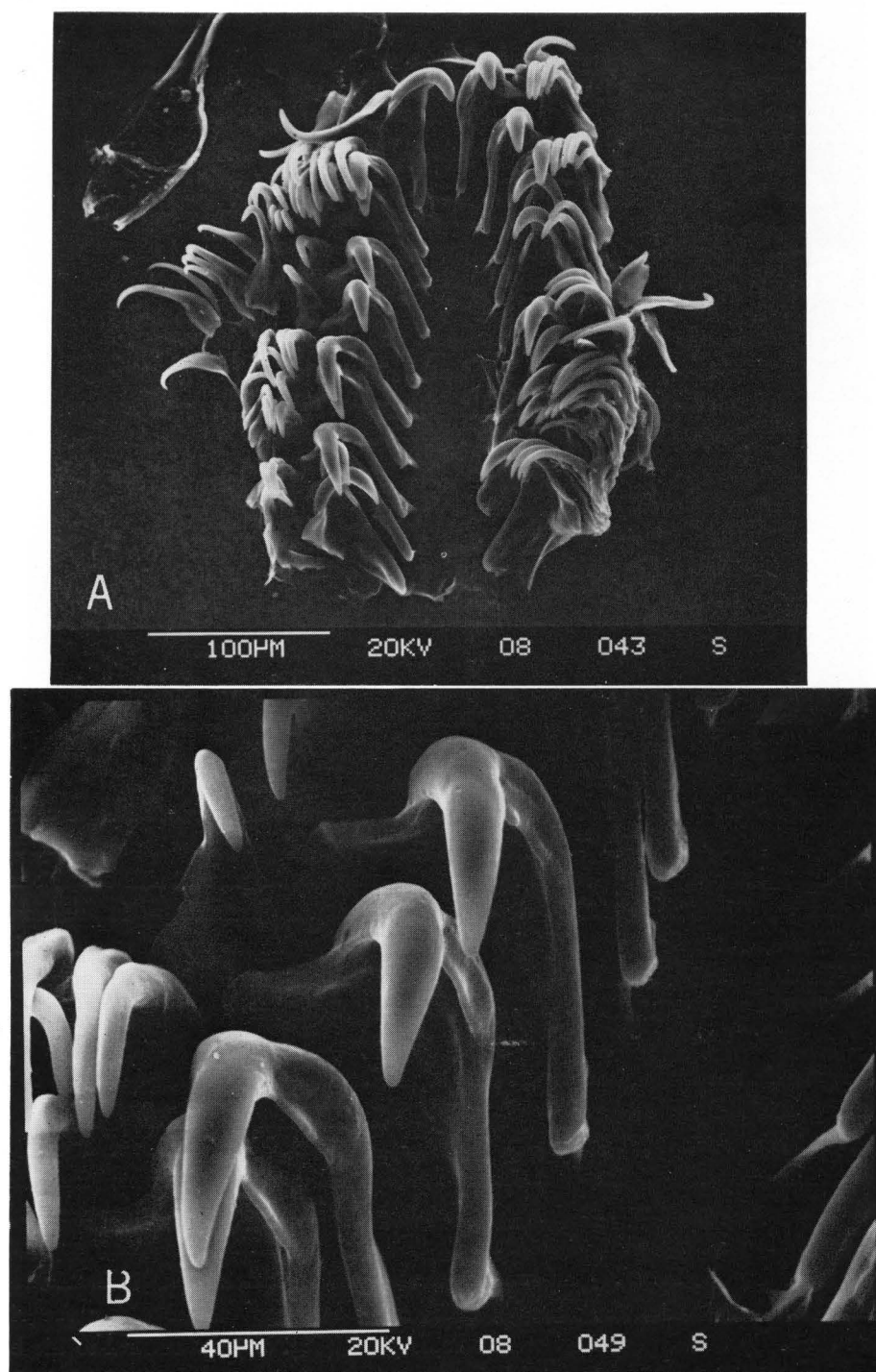


Fig. 3. *Gastropteron flavobrunneum* n. sp., scanning electron micrographs of radula.

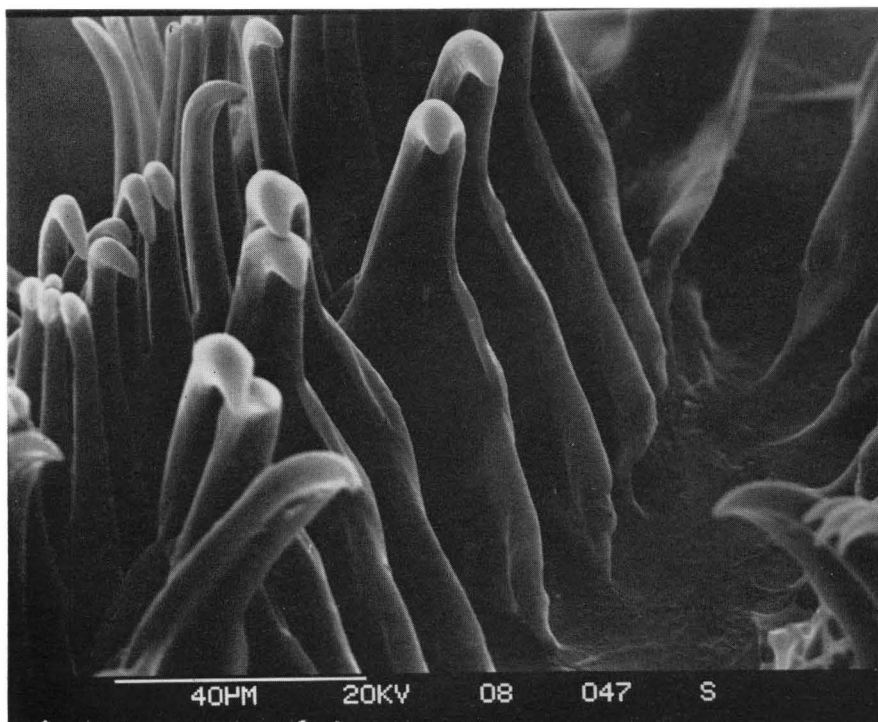


Fig. 4. *Gastropteron flavobrunneum* n. sp., scanning electron micrographs of radula.

Central nervous system. All of the major ganglia are concentrated in the circum-esophageal nerve ring (Fig. 1D). The cerebral ganglia are largest, connected by a short commissure. The pedal ganglia are situated on the ventral side of the buccal mass and are joined by an elongate commissure. The pleural ganglia are smaller than the cerebral and pedal ganglia and are joined to both by short connectives. Immediately posterior to the left pleural ganglion are the subintestinal and visceral ganglia. The suprainintestinal ganglion is situated posterior to the right pleural ganglion and is joined to the visceral ganglion by a short visceral loop. The small buccal ganglia are located on either side of the buccal mass, ventro-laterally to the anterior end of the esophagus.

Reproductive system (Fig. 2B). The ovotestis interdigitates with the digestive gland. The ampulla is narrow. The hermaphroditic duct traverses the female gland mass and terminates at the hermaphroditic genital aperture. Near the middle of its length it joins with the pyriform receptaculum seminis. The bursa copulatrix is ovoid and is joined to the genital aperture by an long duct. From the hermaphroditic genital aperture, the narrow, ciliated sperm groove runs along the right side of the body to the penial aperture. The penis (Fig. 1E) lies ventral to the buccal mass, on the right side of the body. There is an elongate prostate which is thick and convoluted. The spermatic bulb is also elongate and enters the base of the

penis via a thin convoluted duct. The penial papilla is muscular and cylindrical, with a discoidal apex.

Gastropteron alboaurantium n. sp.

(Figs. 5–7, Pl. I Figs. 3, 4)

Holotype: South African Museum, Cape Town. SAM A 35858. Collected in 20 meters of water on a rocky pinnacle off Llandudno on the Atlantic coast of the Cape Peninsula (34°01'S, 18° 20'E) on October 16, 1982. Paratype: California Academy of Sciences, San Francisco. CASIZ 041868. Collected in 31 meters off Llandudno, September 24, 1983 by William R. Liltved.

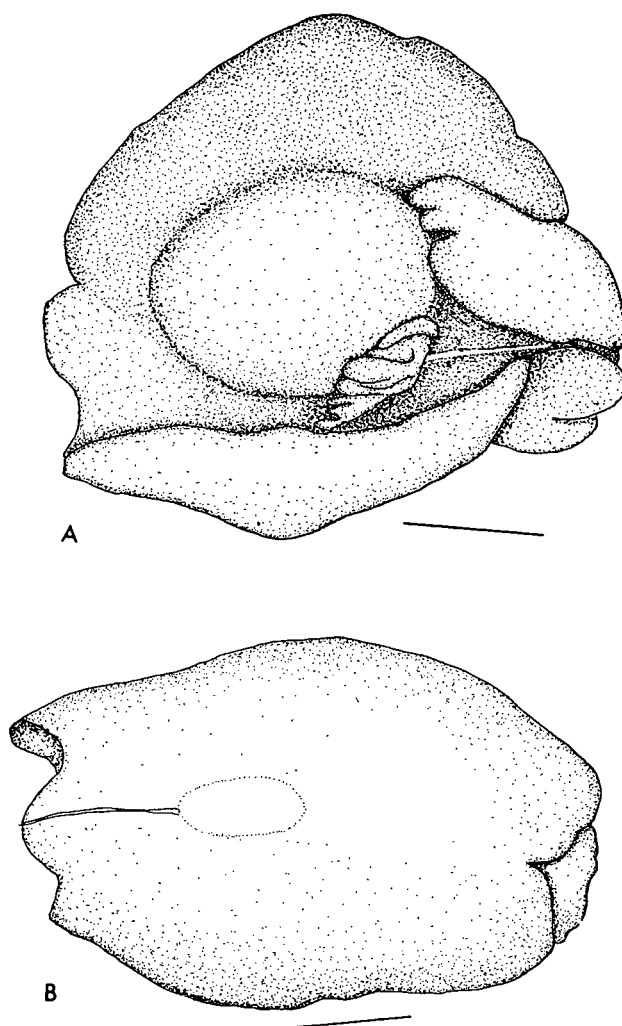


Fig. 5. *Gastropteron alboaurantium* n. sp., A. dorsal view, scale=1.0 mm.
B. ventral view, scale=1.0 mm.

Natural history. A single specimen was found within a meter of a specimen of *Gastropteron flavobrunneum*. Like *G. flavobrunneum*, it was found on a rocky pinnacle covered with small specimens of the mussel, *Aulacomya ater* (Molina). The second specimen was collected from the same habitat. *G. alboaurantium* was also observed to swim by flapping its parapodia.

External morphology. The living animal (Pl. I Figs. 3, 4) is about five mm in length. The ground color of the parapodia is whitish with opaque white spots of varying density. The inner surface of the parapodia is dark grey. The gill is translucent white. The visceral hump and the tip of the siphon are orange. The anterior margin of the head (Fig. 6A) possesses a pair of short, tentacular appendages. The head shield is triangular, broadest anteriorly. The posterior end of the head shield forms a siphon (Fig. 5A), consisting of involuted folds. The thin

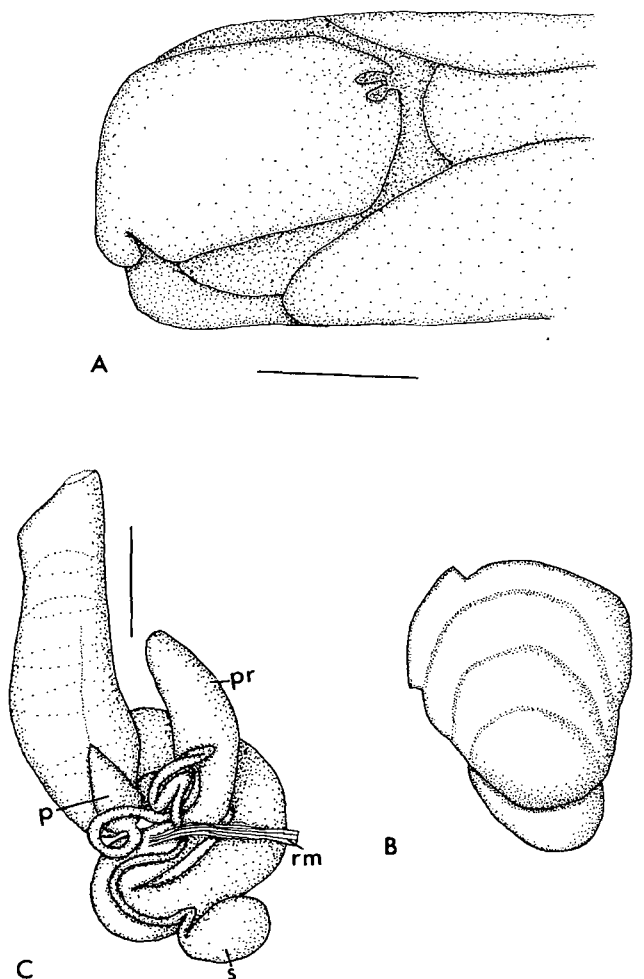


Fig. 6. *Gastropteron alboaurantium* n. sp., A. head, scale=0.5 mm. B. shell, scale=0.5 mm. C. penis, scale=0.5 mm.

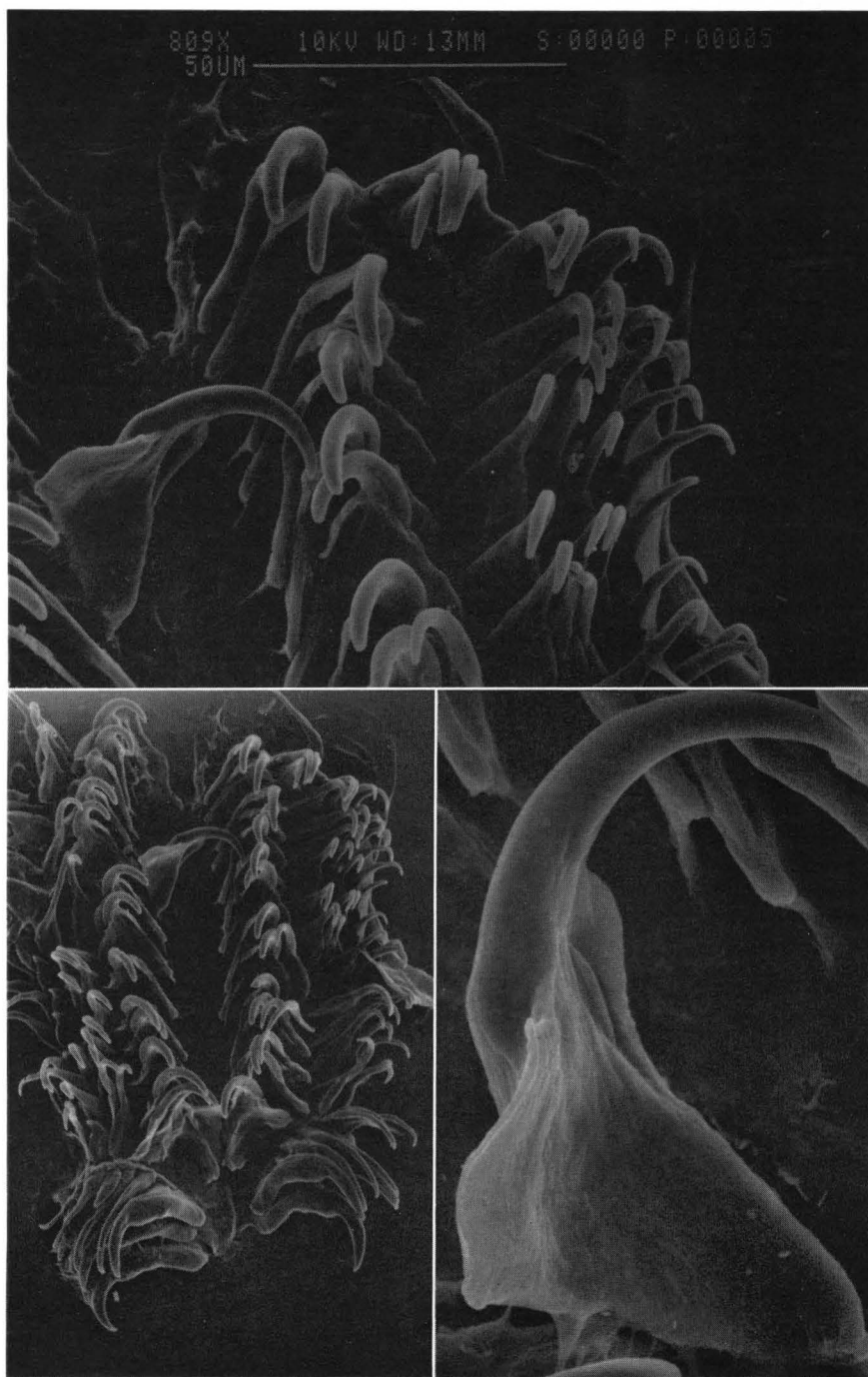


Fig. 7. *Gastropteron alboaurantium* n. sp., scanning electron micrographs of radula of paratype.
A. half of radula, 809 $\times$. B. entire width of radula, 300 $\times$. C. inner lateral tooth, 2000 $\times$.

parapodia are fleshy, terminating near the end of the short foot. The foot is emarginate anteriorly. The posterior half of the foot contains a dermal pedal gland with an elongate, slit-like opening (Fig. 5B). The gill is situated on the right side of the visceral hump. It consists of 13 simple plicae. The anus is located at the posterior limit of the gill. The genital aperture empties into the ciliated sperm groove, anterior to the gill.

Shell. The weakly calcified shell is broad and spatulate (Fig. 6B). The protoconch is not distinctly coiled.

Digestive system. The arrangement of organs of the digestive system is identical to that described for *Gastropteron flavobrunneum*. The labial cuticle is thin and apparently devoid of jaw platelets. The radular formula is $33 \times 4.1.0.1.4$ and $32 \times 4.1.0.1.4$ in the paratype. The innermost lateral is broad with a thickened outer margin (Figs. 7A, C). Its inner margin is curved, without denticles. The outer lateral teeth gradually decrease in size towards the outer margin.

Central nervous system. The arrangement of ganglia is identical to that described for *G. flavobrunneum* and the cerebral commissure is short.

Reproductive system. The distal reproductive organs were not fully mature. The receptaculum seminis is an expanded pouch along the hermaphroditic duct as in *G. flavobrunneum*. The penis (Fig. 6C) has a short, conical penial papilla. The prostate is large, consisting of approximately two coils. There is a spherical spermatic bulb which is connected to the base of the penis by an elongate, convoluted duct.

Gastropteron pacificum Bergh, 1893

(Figs. 8-9A, B)

Gastropteron pacificum Bergh, 1893:303, pl. 16, fig. 28, pl. 17, figs. 10-26.

Gastropteron (pacificum Bergh var.?) *cinereum* Dall, 1925:11, fig. 4. syn. nov.

Gastropteron cinereum Dall, 1925. Tokioka and Baba, 1964:206.

Material: The following description is based on an examination of the syntype of *Gastropteron cinereum* Dall, 1925, USNM (National Museum of Natural History) 333653. This specimen was compared with a specimen of *G. pacificum* collected from an intertidal sand flat at Limantour Estero, California by Michael Gosliner on December 29, 1975.

Description. The preserved specimen (Figs. 8A, 9A) is 11 mm long. The head shield is broad and quadrangular. Its posterior margin is irregularly folded. The parapodia are large and fleshy, extending slightly beyond the posterior margin of the foot. The foot is distinctly separated from the parapodia throughout its length. Anteriorly, the foot is broadest, without a medial emargination. It tapers posteriorly to form a rounded end. Near the posterior limit of the foot is a pedal gland with a short, slit-like opening. The gill is large, consisting of 15 pinnate leaflets. The anus is situated immediately posterior to the gill. The sperm groove extends from the common genital aperture at the anterior end of the gill to the male gonopore on the right side of the head.

The penis (Figs. 8C, 9B) is large and muscular, extending posteriorly for most of the length of the body, on the right side of the visceral hump. The prostate is elongate, consisting of several folds. The penial papilla is discoidal with numerous conical extensions along its anterior margin.

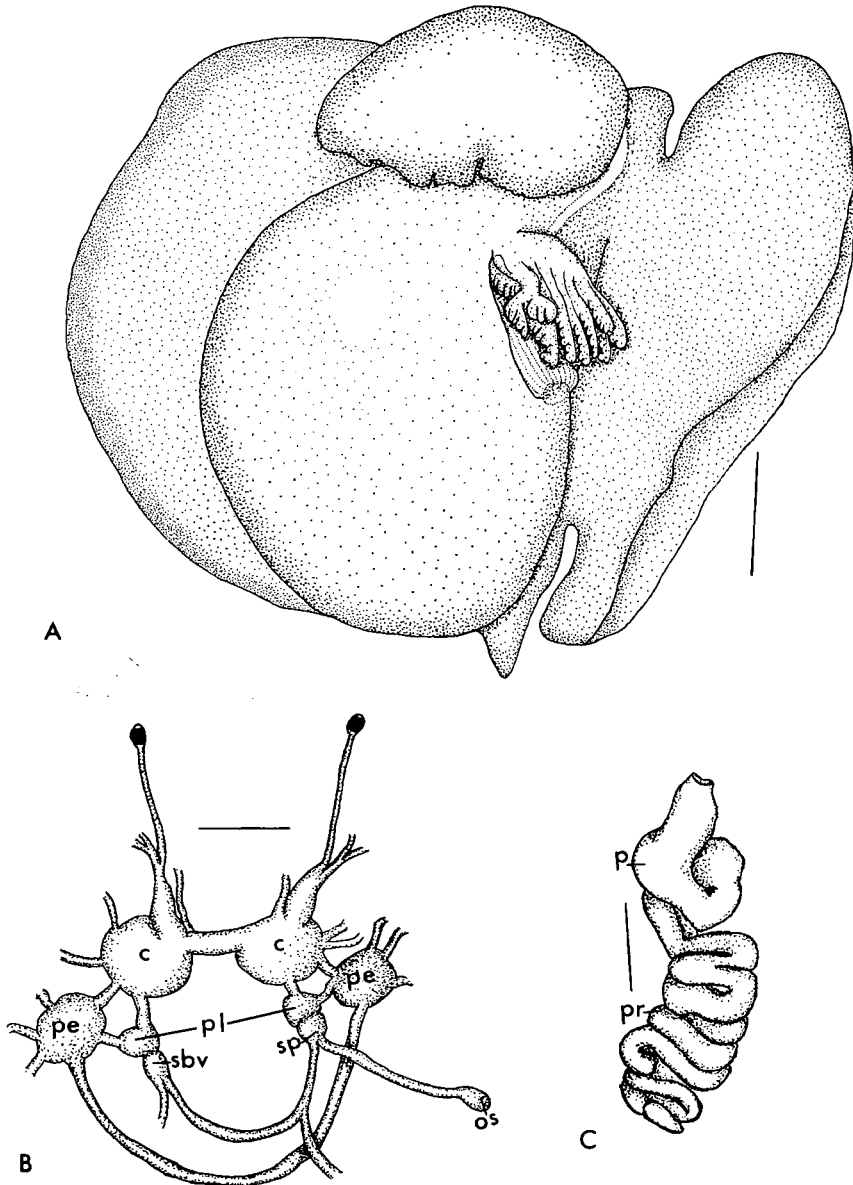


Fig. 8. *Gastropteron pacificum* Bergh, 1893. A. dorsal view, scale=2.0 mm. B. central nervous system, scale=1.0 mm. C. penis, scale=1.5 mm.

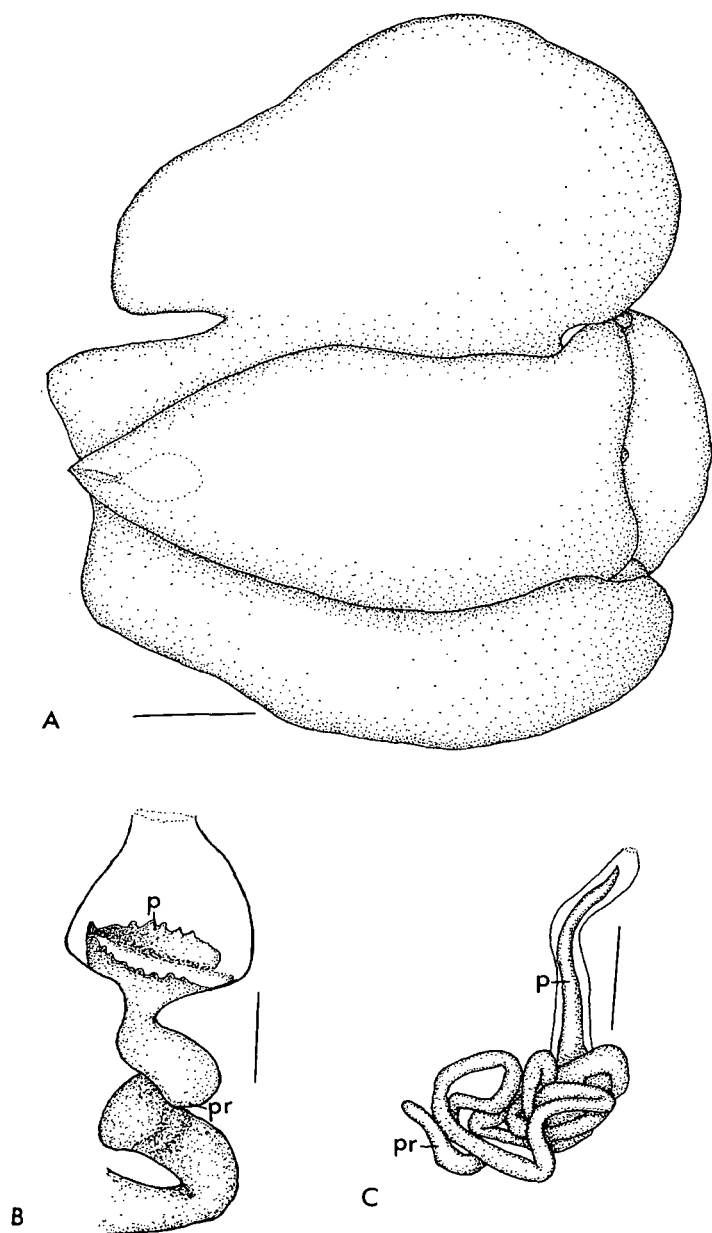


Fig. 9. A. *Gastropteron pacificum* Bergh, 1893, ventral view, scale=2.0 mm. B. *Gastropteron pacificum* Bergh, 1893, penis, scale=1.0 mm. C. *Gastropteron rubrum* (Rafinesque, 1814), penis, scale=2.0 mm.

Discussion

Discussion of Gastropteron pacificum and G. cinereum. In Dall's original (1925) description of *G. cinereum* he listed the species as *G. (pacificum* Bergh var.?) *cinereum*. This suggests that he was unsure about its validity as a distinct species. The only differences which Dall indicated were the dusky body color and smaller body size of *G. cinereum*. The specimen of *G. pacificum* examined here is of the same size as the syntype of *G. cinereum*. The external morphology of *G. pacificum* (Bergh, 1893; MacFarland, 1966; present study) agrees in all respects with that described for *G. cinereum*. The animal has large fleshy parapodia with a well-developed, compound gill. There is no flagellum. The penis of *G. pacificum* was described by MacFarland (1966) and has been re-examined in this study. It agrees in all details with that described here for *G. cinereum*. The only remaining difference between the two taxa is the darker color described for *G. cinereum*. From Dall's description it is unclear whether the slate grey color was present in the living animal or whether this is the color of the preserved specimens. *G. pacificum* is known from Alaska to Baja California. The specimens of *G. cinereum* were collected from British Columbia, within the range of *G. pacificum*. Based on the facts that the two taxa agree in all morphological details and are sympatric, *G. cinereum* Dall, 1925 is here regarded as a junior subjective synonym of *G. pacificum* Bergh, 1893.

Bertsch (1969) stated that *Gastropteron pacificum* is an offshore, pelagic species that is not encountered in the intertidal region. While *G. pacificum* is capable of swimming for periods of several minutes at a time, it is primarily a benthic organism. Intertidal specimens have occasionally been found, including the syntypes of *G. cinereum* and the specimen of *G. pacificum* collected at Limantour Estero and examined in this study.

Discussion of morphological variability within the Gastropteridae. Despite the fact that several species of Gastropteridae have been described in recent years, little is known about the morphological variability within the family (Carlson and Hoff, 1973, 1974). The three constituent genera of the family are distinguishable by differences in radular morphology. The monotypic genus, *Enotepteron* Minichev, 1967, has large denticles on the inner lateral teeth. *Sagaminopteron* is characterized by a broad radula with 9–12 outer lateral teeth per side. In *Gastropteron*, there are two to six outer laterals per side. All other aspects of the internal morphology are known only from two species of *Gastropteron*, *G. rubrum* (Vayssi re, 1885; Bergh, 1893; Guiart, 1901; Marcus and Marcus, 1966) and *G. pacificum* (Bergh, 1893; MacFarland, 1966).

The two species described here have a radula which clearly places them in *Gastropteron*. Members of this genus differ markedly in their external morphology and in some aspects of their internal anatomy (Table 1). Most species possess a flagellum on the right side of the body or a knob on the posterior end of the visceral hump. In the case of *G. bicornutum* Baba and Tokioka, 1965, there are paired flagellar appendages. *G. pacificum*, *G. poh pei* and *G. japonicum*, in addition to the two

Table 1. Morphology of *Gastropteron*.

species	distribution	color	flagellum	gill	radular formula	inner lateral tooth
<i>G. alboaurantium</i> n. sp.	South Africa	white with gray & orange	absent	13 leaflets	32-33 × 4.1.0.1.4	smooth
<i>G. bicornutum</i> Baba & Tokioka, 1965	Japan	yellowish white with black	paired	12-18 leaflets	13-21 × 4.1.0.1.4.	5-10 denticles
<i>G. brunneomarginatum</i> Carlson & Hoff, 1974	Guam	yellow with brown	absent	6-7 leaflets	20-23 × 3.1.0.1.3	8 denticles
<i>G. citrinum</i> Carlson & Hoff, 1974	Guam	yellow on pink with dark brown	elongate on right side	vestigial simple	18-19 × 3.1.0.1.3	1 denticle
<i>G. flavobrunneum</i> n. sp.	South Africa	yellowish with dark brown spots	absent	7-11 leaflets	19 × 5-6.1.0.1.5-6	smooth
<i>G. flavum</i> Tokioka & Baba, 1964	Japan, Guam	yellow with black spots	medial knob	vestigial 4 leaflets	22 × 4.1.0.1.4	12 denticles
<i>G. fuscum</i> Baba & Tokioka, 1965	Japan	brown with white spots	elongate on right side	vestigial 3 folds	—	—
<i>G. japonicum</i> Tokioka & Baba, 1964	Japan	yellowish white with red-orange spots	absent	13 leaflets	19-20 × 5-6.1.0.1.5-6	15-20 denticles
<i>G. ladrones</i> Carlson & Hoff, 1974	Guam	yellow with orange & brown	elongate just to right of median	4 small leaflets	15-19 × 2-3.1.0.1.2-3	1 denticle
<i>G. pacificum</i> Bergh, 1893	Alaska to Gulf of California	yellowish with small red spots	absent	16-20 leaflets	20-22 × 5-6.1.0.1.5-6	12-20 denticles
<i>G. pohnpei</i> Hoff & Carlson, 1983	Ponape	transparent with cream and brown	absent	3 leaflets	18-19 × 3-4.1.0.1.3-4	5-7 denticles
<i>G. rubrum</i> (Rafinesque, 1814)	Mediterranean E. & W. Atlantic	reddish with blue or white margin	elongate on right side	12-30 leaflets	20-40 × 5-6.1.0.1.5-6	4-26 denticles
<i>G. sibogae</i> Bergh, 1905	East Indies	—	small contracted	20-22 leaflets	22-27 × 5.1.0.1.5	smooth
<i>G. sinense</i> A. Adams, 1861	Northern China	brown with crimson markings	—	—	—	—
<i>G. viride</i> Tokioka & Baba, 1964	Japan	greenish with white margin and red blotches	medial knob	8 leaflets	18 × 4.1.0.1.4	10 denticles

species described here, are the only species which lack a flagellum or posterior knob. These three species are significantly different from *G. flavobrunneum* and *G. alboaurantium* in that they possess denticles on the inner lateral teeth of the radula. The only previously described species which lacks denticles on the inner lateral teeth is *G. sibogae* Bergh, 1905.

The central nervous system has only been examined in *Gastropteron rubrum* (Vayssiere, 1885, Guiart, 1901). Re-examination of specimens in this study confirm Vayssiere's description of the arrangement of ganglia. *G. pacificum* has an identical arrangement of ganglia (Fig. 8B). *G. alboaurantium* and *G. flavobrunneum* differ significantly in that the cerebral ganglia are separated by a short rather than long commissure.

The reproductive system of *Gastropteron rubrum* is monaulic with an elongate ampulla which traverses the border of the female gland mass and joins it at the common genital aperture (Guiart, 1901). The same configuration is present in *G. pacificum* (MacFarland, 1966) and *G. flavobrunneum* (Fig. 2B), except that a distinct, pyriform receptaculum seminis is present along the hermaphroditic duct.

The penis has also been described in only the same two species, *G. rubrum* (Guiart, 1901; Marcus and Marcus, 1966) and *G. pacificum* (MacFarland, 1966). Both of these species were re-examined in the present study (Figs. 8C, 9B, C). *G. rubrum* can be distinguished by its elongate, conical penial papilla while *G. pacificum* has a broad, discoidal papilla with conical warts. Neither species possesses a spermatid bulb which is present in *G. flavobrunneum* and *G. alboaurantium*. Certainly a great deal more information is required to determine the range of variability of penial morphology within the Gastropteridae.

Gastropteron flavobrunneum and *G. alboaurantium* are more similar to each other than to any other described members of the genus. Both species have an elongate body form, thin parapodia and lack flagella or knobs on the visceral hump. The two differ significantly in their coloration (Pl. 1). *G. alboaurantium* has digitiform lobes on the anterior end of the head, which are absent from the simply rounded head of *G. flavobrunneum*. The two species differ markedly in the configuration of their radular teeth. *G. flavobrunneum* has 19 rows of radular teeth with five or six outer laterals per side while *G. alboaurantium* has 32–33 rows of teeth with four outer laterals per side. The shape of the radular teeth is similar in both species.

The most significant difference in internal morphology between *Gastropteron flavobrunneum* and *G. alboaurantium* is in the penial morphology. While both species possess a thick prostate and a spermatid bulb, the shape of the bulb differs. *G. flavobrunneum* has an elongate bulb while it is spherical in *G. alboaurantium*. The papilla is short and conical in *G. alboaurantium* and elongate and cylindrical with a discoidal apex in *G. flavobrunneum*.

The only other species recorded from southern Africa is *Gastropteron* sp. (Barnard, 1963). The species was trawled in 1,380–1,520 fathoms off the Cape Peninsula. Little of its morphology was described. The specimens are no longer present in the collections of the South African Museum, but a damaged radular slide of a



Fig. 10. *Gastropteron* sp., radular teeth, scale = 250 μ m.

specimen (SAM A 9833) was remounted (Fig. 10). The radular formula is $15 \times 4.1.0.1.4$. The inner laterals are devoid of denticles as in *G. alboaurantium* and *G. flavobrunneum*, but are significantly narrower. *G. sp.* most probably represents a distinct, undescribed species, but additional material is required to verify its status.

The present study indicates that external morphology is important in differentiating species of *Gastropteron*. It also suggests that there are significant differences between species in the morphology of the central nervous system and penis. These characters appear to be taxonomically important but a great deal more information is required to establish their significance and variability within the Gastropteridae.

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EXPLANATION OF PLATE I

- Figs. 1, 2. *Gastropteron flavobrunneum* n. sp., living animal.
Figs. 3, 4. *Gastropteron alboaurantium* n. sp., living animal.



1



2



3



4